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Season's
Greetings
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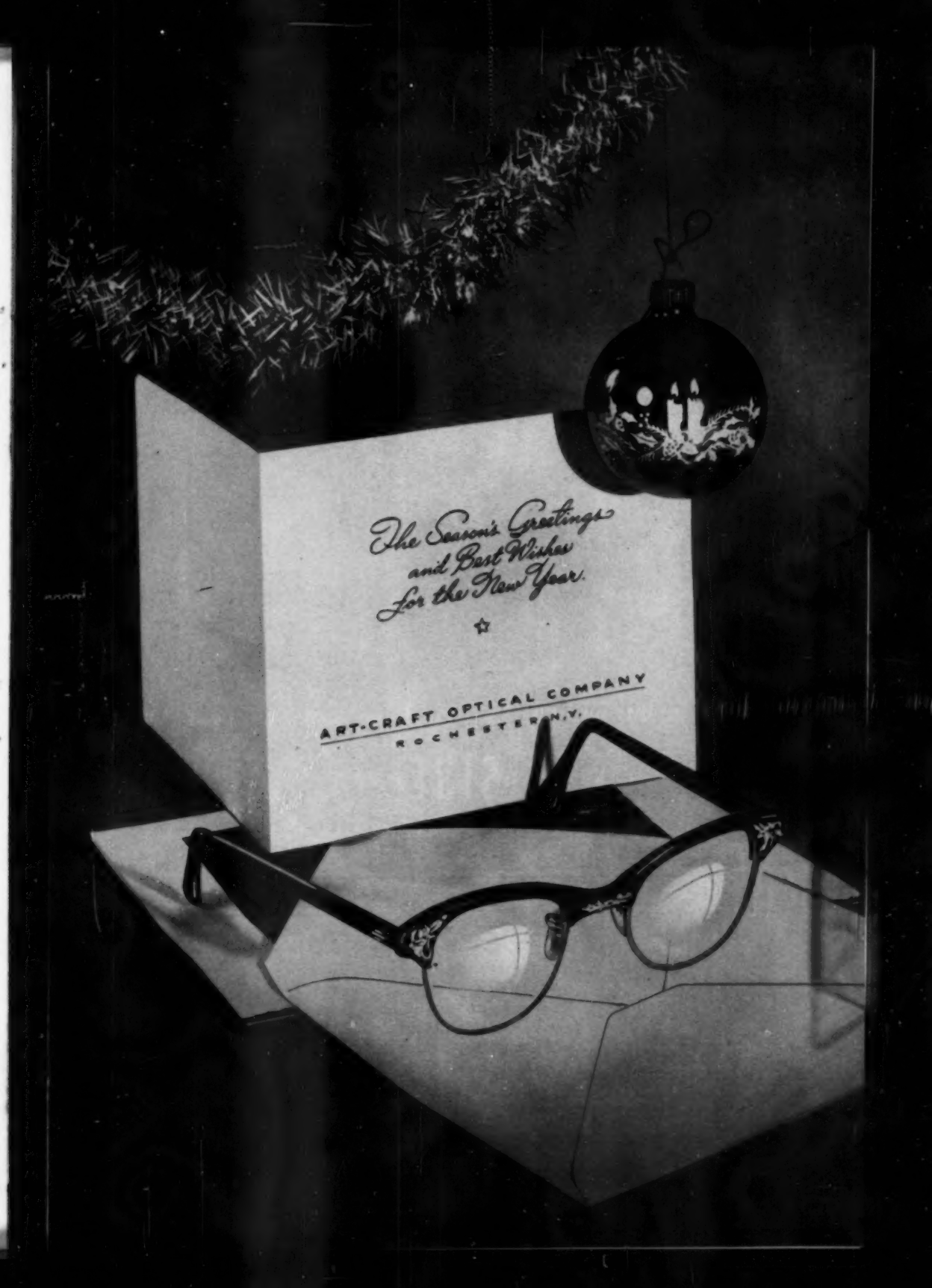
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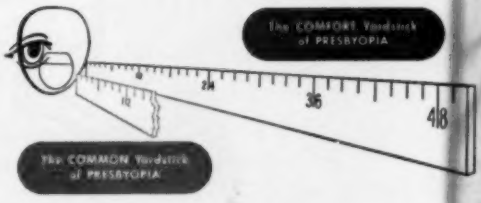

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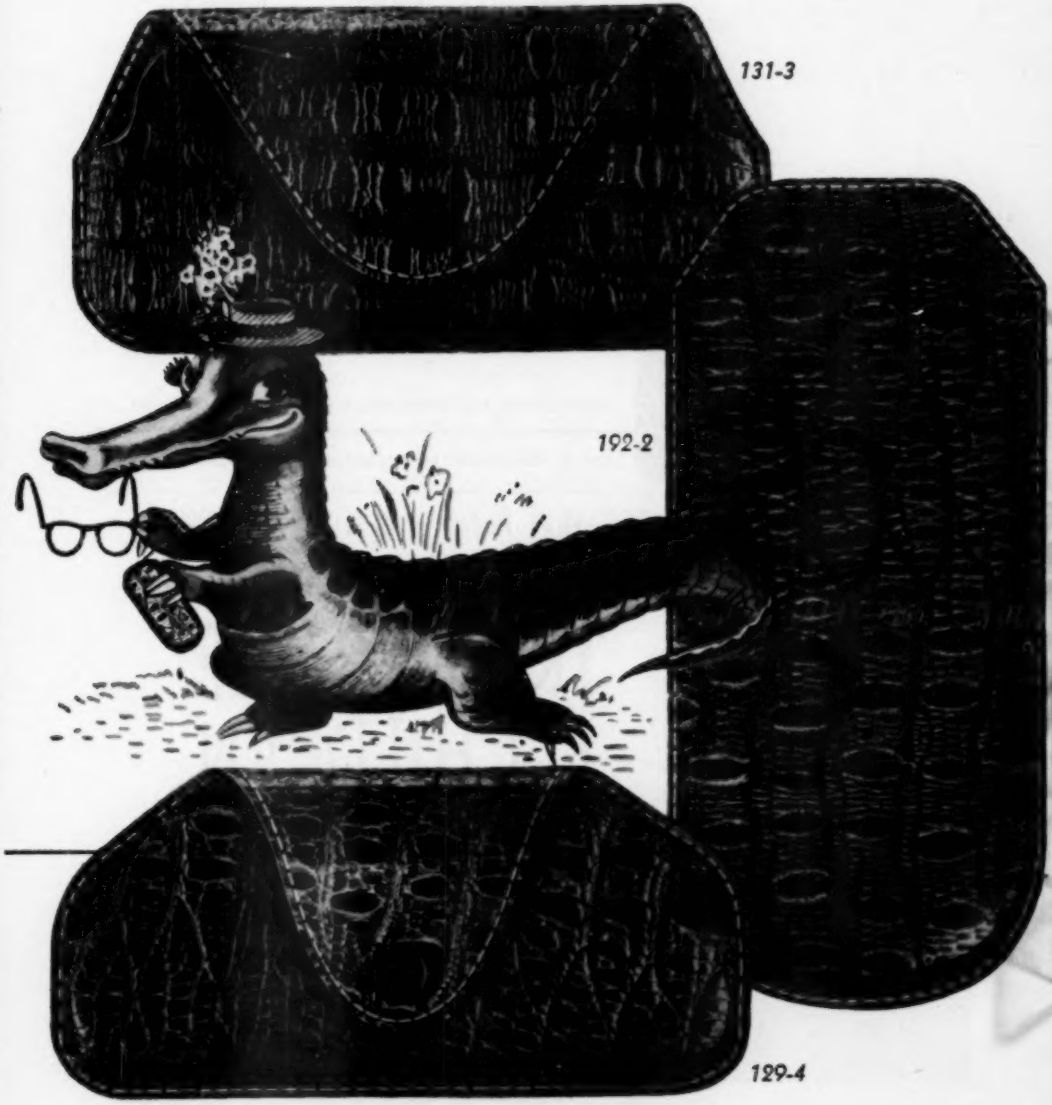

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Vol. 28 December, 1951 No. 12

OCULAR MOVEMENTS AND FIXATIONS IN READING*

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As you read this paper, your eyeballs are moved to a certain point in the line of print called a fixation point. Here they pause for a short time (fixation pause) to allow perception or understanding of that material to take place. They are then moved (saccadic movement) to the next fixation point. Occasionally they are moved back to some point in the material that was previously read for a refixation. This is called a regressive movement.

The following material discusses the saccadic and regressive movements and the fixation pause. The writer will explain briefly the musculature involved in moving the eyes and discuss fully the saccadic and regressive movements and the fixation pause and how they relate to the final ability to read.

It has been shown[8] that adult subjects read material such as *The Outline of History* by Wells at the rate of about 23 four inch lines per minute during a period of one hour of continuous reading. If this rate were maintained during an eight hour day, the eyes of the reader would critically cover about 3,700 feet of printed matter or more than 2/3 of a mile. An additional 2/3 of a mile would be covered by the eyes shifting from the end of one line to the beginning of the next.

In addition to this, the average reader at college level makes about six saccadic movements and fixations during the reading of a single line of print and thus in the course of eight hours, the eyes are "started" and "stopped" about 70,000 times.

These movements are accomplished by the simultaneous action of six extrinsic muscles of each eye acting with smooth coordination

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with each other. The muscles are inserted into the eyeballs in such a way that they can turn the eye in any direction or rotate it, almost like a wheel about an axis.

Because of their peculiar attachments to the eyeball, most of the muscles have more than one action. These actions can be referred to as primary and secondary actions. The following chart lists the six extra ocular muscles of each eye and shows their primary and secondary actions. The letters R and L refer to the relative direction of pull for the muscles of the right eye. The lateral direction for the same muscles of the left eye would be exactly the opposite, the vertical components being unchanged.

MUSCLE	PRIMARY ACTION	SECONDARY ACTIONS
Internal Rectus	Turns eye laterally inward towards nose (L)	
External Rectus	Turns eye laterally away from nose (R)	
Superior Rectus	Turns eye up	(a) Towards nose (L) (b) In Torts (L) (Rotates upper portion towards nose—lower portion away from nose)
Inferior Rectus	Turns eye down	(a) Towards nose (L) (b) Out Torts (R) (Rotates upper portion away from nose. Lower portion towards nose)
Superior Oblique	In Torts (R)	(a) Turns eye down (b) Turns eye away from nose (R)
Inferior Oblique	Out Torts (L)	(a) Turns eye up (b) Turns eye away from nose (R)

In moving the eyeball in any particular direction, certain muscles are called into play as the main and synergistic muscles and others as antagonistic muscles to check the total movement of the eye.

An example of the coordination of these muscles can be shown in turning the right eye to the left. This is performed mainly by the internal rectus, but it is assisted by its synergistic muscles, superior rectus and the inferior rectus. Since the other actions of these two muscles are exactly opposite to each other, they are cancelled and the eye is turned only in the one direction.

The antagonistic muscles that turn the eye to the right, (the external rectus and the superior and inferior oblique muscles) are relatively relaxed at the beginning of the movement, but they control the total distance through which the eye is moved. The secondary actions of these antagonistic muscles are cancelled since the muscles work opposite to each other in those directions.

When both eyes are used, the six muscles of each eye are coordinated to bring about the desired movements in a smooth, efficient manner. When both eyes move simultaneously in the same direction and the same amount, a conjugate movement results. This conjugate movement would be expected in reading where the eyes move from left to right across the page. However, in actuality, there is a tendency for both eyes to slightly diverge or turn away from each other during each fixation pause and at the end of reading line of print. This vergence phenomenon[1] is neutralized during the eye movements from fixation to fixation and during the return sweep where the eyes are brought to the next line of print.

Saccadic Movements: These are the movements where the eyes are brought from one fixation point to another by the simultaneous expansion and contraction of the various extra ocular muscles involved.

Diefendorf and R. Dodge[1] conducted interesting experiments to determine the amount of time that elapses between the presentation of a stimulus in the outer portion of the visual field and the beginning of a saccadic movement. They found that on the average the elapsed time was only 195 milliseconds (ms is 1/1000 of a second) with a range from 125 to 235 ms.

The study relative to the speed of eye movements was continued by Dodge and T. S. Cline.[1] The following chart shows the results of their experimentation to determine the actual duration of the saccadic movement or the amount of time the eyes actually moved.

EXTENT OF MOVEMENT	DURATION OF MOVEMENT
5 degrees	29 ms.
10 degrees	39 ms.
15 degrees	48 ms.
20 degrees	55 ms.
30 degrees	80 ms.
40 degrees	100 ms.

These findings were taken at a distance of 12″ where a 5 degree movement of the eyes covers a linear distance of approximately 1″. Note that the speed of travel is relatively greater for the greater distances. Although it is possible to control the extent and direction of saccadic movements, the speed cannot be controlled. Actually only about 10 per cent of the total reading time is spent in moving the eyes.

Regressive Movements: Since all books of the English-speaking world are printed from left to right, it is expected that all saccadic movements would be from left to right. However, there are often saccadic movements to the left to refixate material previously observed

on the same line or page. These are the so-called regressive or corrective movements.

In general they take place as a corrective adjustment when a difficult or interesting detail is encountered or when comprehension is poor and it is necessary to review the material.

Regressive movements accompanying the slow reader may be due perhaps to a lack of familiarity with language forms and thus the associated inability to get meaning from the phrase read. They also are present in careful and detailed reading in scientific papers, for example, where each phrase qualifies the final analysis.

Another type of regressive movement is found near the beginning of a passage or when just beginning to read, before the motor actions of reading are fully established.

Although most expert readers regress when reading, it has been found that the number of regressions decrease with age and experience. Expert readers regress most often at or near the beginning of a line of print after a long return sweep.

The following chart points out graphically this decrease in regressive movements with age and thus experience.[1]

Age	No. of Regressions per line	Age	No. of Regressions per line
6	5.1	13	1.5
7	4.0	14	1.0
8	2.3	15	.7
9	1.8	16	.7
10	1.4	17	.7
11	1.3	18	.5
12	1.6		

Work at the Dartmouth Eye Institute correlated regressive movements with academic standings and it will be noted that the student of average standing made fewer regressive movements than the inferior and superior students, who made approximately the same number of movements. This seems to indicate that a larger than usual number of regressions does not insure poor reading. This study tends to show that regressive movements may be desirable for superior students. An interesting point is that although more regressive movements were made, the superior student read more words per minute than the average student and made fewer fixations in doing it.[2]

Gray[7] studied the relative time spent in a pause at the end of a regression and found there were both short and long pauses. It is generally believed that the short pauses are merely for readjustments on the

Academic points received in 1 yr.	No. of students	Fix. per 100 words	Reg. per 100 words	Words per minute
20-39	52	76.4	15.0	341.3
40-49	88	76.8	14.2	330.1
50-59	106	74.2	14.3	337.3
60-69	140	75.1	12.6	340.0
70-79	82	72.9	12.1	261.1
80-89	57	70.9	11.9	358.3
90-99	44	68.5	13.4	387.0
100-109	20	53.1	13.5	351.9
110	4	67.0	7.0	442.0

page, while the long pauses are long enough for perception of the material to take place.

Fixations and Fixation Pauses: A printed word, to be seen, must have its image fall on the retina. Actually, the portion of the retina that provides the sharpest vision (fovea) is an area approximately 1/100 of an inch in diameter. This image must be relatively stationary on the fovea for a period of time to allow a mental impression to take place. Thus the purpose of all extra ocular muscle actions is to bring the fovea to the image and then to hold the eye steady. This relationship is brought about by (1) a stationary object in conjunction with a stationary eye, or (2) if the object is moving, the eyes must move proportionally (pursuit movement). If these relationships do not hold, vision is blurred unless the movement of the object or eye is very slow.

Thus, seeing a word takes place only during the fixation pause, for, during the saccadic movement, the eyes are moving very rapidly and the image of the stationary line of print moves across the retina as a streak or blur. This is of extremely brief duration due to the high speed of eye movement. It is because of this brief time that the impressions are disregarded. The overlooking of this rapid blur is called central anesthesia.

Holt, Dodge, and Woodworth[1] have all worked on this phase of reading and are agreed that the reader fails to see these fleeting impressions because his perception of them would interfere with the main business of reading.

The number of fixation pauses decreases with age and experience as does the number of regressive movements. The following chart incorporates both the number of regressions and fixations per line of print and the average duration of the fixation pause for the purpose of comparison.[7]

It is interesting to note that the duration time of the fixation pause remains relatively constant beyond the age of 10 or 11 years.

Age	Average No. Reg. per line	Average No. Fix. per line	Average duration of fixation pause
6	5.1	18.6	660 ms.
7	4.0	15.5	432
8	2.3	10.7	364
9	1.8	8.9	316
10	1.4	7.3	268
11	1.3	6.9	252
12	1.6	7.3	236
13	1.5	6.8	240
14	1.0	7.2	244
15	.7	5.8	248
16	.7	5.5	224
17	.7	6.4	248
18	.5	5.9	252

while the number of fixations and regressions continues to decrease. This seems to indicate that the duration of the fixation pause is relatively unaffected by the conditions governing the number of fixations.

Evidence is available to support this contention. It is shown quite readily by increasing the difficulty of the reading material and comparing the number of fixations and the duration of the fixation pauses. While the duration of the pause remains relatively constant, the number of fixations and regressions increases.

This shows, that on the average, the improvement of the reading is based on the decrease in the number of fixations (including both saccadic and regressive fixations) rather than the decrease in the duration of each fixation.

Gray[7] differentiates two types of readers relative to the duration of the fixation pause and the number of fixations. One type keeps the number of fixations to a minimum and the other type keeps the duration of the pauses to a minimum. He believes that those who keep the number of fixations to a minimum have longer pauses and those who keep the duration of the pause to a minimum have more fixations.

It is his contention that the readers making few fixations have a "wide scope of attention" while those who make more fixations are quicker in perceiving what they see, but they have a more narrow scope of attention.

It can easily be seen that with a greater number of fixations in a line of print, smaller relative units are perceived and thus rapid reading is impossible. Gray found, however, that those who make the fewest fixations in a line are not necessarily those who read the most rapidly.

The following figures derived from his[7] experiments show the relationship between the number of fixations and the reading rate of the fastest readers in the grade groups studied and the speed of reading and

fixations of the person making the fewest pauses.

Grade	No. Fix. of most rapid reader	Reading rate (Av. words per second)	Fewest fix. of any subject	Reading rate (Av. words per second)
3	7.1	4.1	6.2	3.1
4	6.7	2.4	5.6	4.3
5	7.0	3.2	7.0	2.5
6	5.8	5.1	4.0	3.5
7	7.0	4.3	4.6	2.8
H. S.	6.3	5.0	4.6	3.3
C	5.2	6.8	5.0	5.8

Note that in almost every grade group, the most rapid reader made more fixations. These figures seem to be in accord with Gray's ideas of attention span. It may be that the more rapid readers have a wider scope of attention. However, on the average, the more rapid readers do make fewer fixations than the slow readers. The writer would like to point out that remedial reading classes spend a great deal of time and effort in reducing the number of fixations and regressions in slow readers.

Cattell[7] exposed letters, phrases, and sentences to subjects for short periods of time and found that the time required for the recognition of a word was no greater than that for a letter. He also found that in many cases where sentences or phrases were exposed for short times that they were often grasped as complete units.

We know then that the natural form of reading is not in spelling out the words letter by letter or by syllables, but by grasping whole groups of words. However, it is not very well explained or understood what causes the eyes to skip certain things and stop at a particular point for a fixation. It is known that the eyes do not fixate the same relative point in space on every line of print. There seems to be no particular preference for fixating any special type of letter or length of word. The exact location of a fixation pause in a line depends only slightly on how the general space of the line is filled.

The features of a line of print that may act as cues for a fixation could be the overall shape of the words, the pattern formed by the letters of a familiar word, and the so-called dominant letters in a word or phrase although there is little evidence supporting this last possibility.

It has been found that in presenting nonsense and actual words to observers for short periods of time with the tachistoscope that words similar in shape to the ones presented were reported.

Wilkins[7] experimented with familiar letter groups and found that

the readers reported familiar words having that particular letter combination. An example of this is in presenting such nonsense words as PSYCHMENT DEPARTOLOGY a response of PSYCHOLOGY DEPARTMENT was given. TALCUM POWDER was the response for TALDER FOWCUM and WASHOUT IRVINGTON produced the response of WASHINGTON IRVING.

Messmer[8] studied the individual characteristics of letters and classified them as to breadth, height, and geometric form.

He places little significance on breadth as the width of an "n" or "m" disappears in the total perception of the whole word. However, he places great emphasis on the difference in height between an "h" and an "a" for example, or letters composed of combinations of curved and vertical lines.

It is my belief that the form of the letters has a very minor role in the selection of a fixation point unless one letter or a combination of letters is quite distinctive. For example, "Egypt" has three tails in one group below the line. This is uncommon and thus influences the fixation. "Piazza" with a double "z" has an odd combination and thus catches the attention of the reader.

Goldscheider and Müller[5] called some letters "determining letters" and others "indifferent letters." They pointed out that some letters can be omitted from a word and yet the word may be easily recognized. For example, if "letter" is written as "l-tt-r" it can be read. In this case "e" is an indifferent letter and the others are determining letters. Consonants compose most of the determining letters because most of them pass above or below the line.

No one cue of the many possibilities discussed has been found to be dominant in its usefulness to aid the reader in picking fixation points.

Actual seeing of a few letters next to the fixation point whether near the beginning, end, or middle of the word, or the position of letters that project above or below the line, and the location of the rounded letters or oblique lines, may give a distinctive appearance to a word or phrase enabling it to be perceived without actually seeing all of its parts.

The reading of familiar phrases requires few pauses, while proper names and titles and unfamiliar phrases require more fixations.

Another factor that must be taken into account at this time is indirect vision. We know that each letter is not seen directly during a fixation pause due to the smallness of the fovea which is the area of sharpest vision and yet is only approximately 1/100th of an inch in diameter. If this area would be projected to the normal reading distance

of 13-14", it would include only a few letters and so it is believed that the areas around the fovea are utilized to view indirectly the letters not actually fixated.

Hamilton[5] used the tachistoscope to project lines of print on a screen for a single fixation. He had the subjects repeat as much as possible of their impression of the line. The response of the subjects showed the first and sometimes the second words to be correct, but beyond that there were only guesses. The important thing, however, is that the guesses often resembled the next word. The words that were guessed had to fall on the areas around the fovea (extra-foveal areas).

Stimulation of these extra-foveal areas produces relatively blurred and poor images because the sharpness of vision is reduced greatly just a short distance away from the fovea. However, Hamilton's experiment points out that the peripheral vision does help the perception of what will be next read, and thus helps in the selection of the next fixation pause.

During the fixation, the word or letters directly viewed fall on the fovea and are seen clearly. The letters outside this direct fixation area fall on less sensitive retinal areas and cause images less sharp and clear so as not to interfere with the immediate fixation. However, this blurred image is to some extent appreciated and perceived so that at the next fixation, when this blurred image becomes sharp, complete perception of that fixation is made easier.

It is interesting to note that when reading Braille, the blind have one finger in advance of the "reading finger." This is their way of compensating for the peripheral span.

Peripheral vision works vertically as well as horizontally. Dearborn[1] found that in reading long lines of print, the vertical perception span interferes with the comprehension since the lines above and below do not bear directly on the line being read as they would in a newspaper where the lines are short and thus the vertical span aids comprehension.

Erdmann and Dodge[7] showed that although words are readily distinguished when written or printed on a horizontal line, they are not readily recognized if printed in a vertical column although the order of the letters may be the same.

I believe this is due to our experience of reading material printed with horizontal lines only. I believe that if the experiment were repeated with Chinese readers, for example, an opposite reaction would be found.

In summarizing the material presented, we can show:

A. Fixations after a forward saccadic movement divide themselves into three classes:

1. Those which are determined by the length of the span of attention.
2. Those which fall within or near short words.
3. Those which are used in making detailed analysis of single words.

B. Regressive movements can be divided into:
1. Those which accompany slow tedious reading due to language difficulty and failure to get meaning.
2. Those which accompany very rapid reading where it is necessary to go back and connect what has been read.
3. Those used in careful, detailed reading.

C. The number of fixation pauses decrease with age and experience while the duration of the pauses remains relatively constant indicating that the span of attention changes more than the speed of perception.

D. A large number of fixations and regressions results in slow reading, while a small number of fixations and regressions improves the reading rate.

E. The natural form of reading is not spelling out words by letters or syllables but by grasping whole groups of words.

The writer would like to point out that the foregoing material has been limited to a very small area in the total act of reading. Even with perfect fixations and a minimum of saccadic and regressive movements, the reading efficiency can be reduced.

Anomalies of the muscles (both extra ocular and intra ocular), anomalies of the refracting ability of the eye and its complex associated nervous system including the brain itself, can cause reduced efficiency.

Psychological set, intelligence, physical well being, and all the external factors such as illumination, the quality and color of the paper used, the size and style of the type face, and even the distance between the lines affect the efficiency of a reader.

This is not intended to be a complete list; there are many other factors not mentioned. It is just a means of pointing out the complexity of the task of reading, and the many ways in which the comfort and ability of a reader are influenced.

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ABSTRACTS

TESTING EYE MUSCLES. E. R. Powener and K. S. Lion. Electronics. 23.3. 96-99. 1950.

This paper describes the need, the theory and the application of an electronic instrument for measuring and recording the "muscular strength" of the extrinsic eye muscles.

Previous investigators have demonstrated that the eyeball is electrically polarized and may be represented by a sphere with a positive and negative pole. Two electrodes, placed on opposite temples, record these eye potentials. The potential measure depends on the angular position of the eyeball left or right of center.

The authors' mathematical treatment of the problem may be summarized as follows: 1. The potential developed by the eye is directly proportional to the angular displacement of the eye ball. 2. The muscular force required to turn the eye is proportional to the second derivative of the output voltage arising between the electrodes attached to the subject's temples.

The investigators have three measurements available: The potential, e, created by the angular displacement: the first derivative of the potential which is actually the angular velocity with which the eye turns; and the second derivative of the potential, e, the angular acceleration with which the eye turns. It is this last value which is proportional to the muscular force.

When a subject is reading and the output voltage is applied to an oscillograph, the following oscillograms are obtained: The displacement potential appears as a series of saccades, the flat portions representing fixations and the vertical portions representing inter-fixation movements. (Note the similarity to the Ophthalmograph picture!). The velocity is a saw-tooth wave; and the acceleration appears as a series of pulses whose amplitude is a function of the muscular force. An electronic marker circuit supplies time markers every two seconds.

The authors indicate, in general, that the muscular forces expended for the inter-fixation movements and the return sweeps are "surprisingly constant" for any one subject. That is, very little visual fatigue is observed. The records may be applied to physiological investigations and medical diagnosis. In particular, the procedure is expected to be very useful in the investigation of visual fatigue.

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CONTACT LENS FITTING IN THE UNITED STATES*

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There are currently in use in the United States many different types of contact lenses. For the purposes of this discussion these will be divided into three different categories, as follows:

1. The conventional fluid type lens. This type employs a scleral rim to support a large corneal section which spans both the cornea and limbus, the corneal portion of which contains the required ophthalmic correction. This type of lens may be either custom made from a mold of the eye, or it may be of the preformed type fitted from a trial case.

2. The corneal cap lens. This lens is in the form of a thin meniscus having a diameter slightly less than that of the cornea. The lens is held in place on the cornea by capillary adhesion.

3. The minimal clearance lenses. These all have a scleral rim to support the corneal section. Some of these lenses require the use of an auxiliary fluid while others depend upon the tears to fill the minimal space which lies between the contact lens and the cornea.

Before discussing the individual lenses which fall into each of the above categories, I would like to digress for a moment to mention what I consider to be the essential characteristics of a well fitting contact lens. These characteristics are: (1) That the lens should be comfortable to the wearer, i. e., he should be able to wear the lenses for a long period of time without experiencing irritation, smarting, photophobia, or other symptoms of discomfort: (2) The lens should not cause the development of an oedema of the corneal cells with resultant steaming or "hazing" of vision: (3) The lens should look well from a cosmetic standpoint, i. e., it should not widen the palpebral aperture materially and it should not cause the eye to appear to bulge outward: and finally, (4) The lens should lend itself to proper fitting with a minimum number of visits so that the cost to the patient need not be exorbitant for the monetary return to the fitter to be adequate.

Today, in the United States, only a few contact lens practitioners

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are using lenses which fall into the first category, either the preformed or the molded type. Although there is a difference in the problems encountered in adjusting the two different types of fluid-using lenses, there is very little difference in the lenses as finally fitted. Generally, lenses of this category have a large corneal section and a deep water lens chamber. These characteristics result in poor cosmetic appearance as they cause wide apertures and bulging eyes. Usually too, these lenses produce a sagging and a wrinkling of the lower lids. Most persons wearing this type of lens develop a corneal oedema within a few hours. Usually such lenses are comfortable to the wearer and do not present much difficulty in the way of fitting.

While some of the adjustments on this type of lens can be made by grinding or scraping the plastic—followed by a repolishing, most of the adjustments are made on the peripheral edge of the scleral rim by the use of a pair of heated forceps, such as the radius adjusting forceps developed by Feinbloom.

The practice of making thermal adjustments has become widespread and has been applied to all types of lenses except the corneal caps. Unquestionably this method of adjusting is effective and time saving. However, there are certain cautions which must be observed in the application of heat to lenses of different manufacture. Lenses made by Feinbloom and several other laboratories are pressed from sheets of plexiglass. These lenses are under strain and should not be adjusted with inadequately heated forceps. In fact, the forceps should be heated a full minute in boiling water before they are applied to the plastic. Lenses made by the Mullen Laboratories are injection molded. In handling these lenses the operator should see that his forceps are immersed in boiling water for 10 seconds before attempting the adjustment. Lenses made in the Nupuf Laboratories are made by polymerization in a vulcanizing flask. Such plastic cannot be adjusted with forceps heated to only 100° C. Thermal adjustments can be made on these lenses if the forceps are first heated by immersion in boiling paraffine.

The danger in making thermal adjustments lies in having the plastic at an improper temperature for manipulation. Feinbloom and Nupuf lenses are adjusted after the ophthalmic correction has been applied. If correct temperatures are not used, there is great danger of warping the corneal surfaces. When the lenses are inspected in air, this fault does not usually reveal itself because the toricity of the two surfaces neutralize each other. However, when the lens is on the eye, a high astigmatism results from the warped area over the cornea.

A few practitioners have attempted to convert the conventional lens

to a minimal clearance lens by opening up the scleral rim. Usually such attempts have been unsuccessful because of the short radius on the posterior surface of the corneal section which precludes the obtaining of minimal corneal clearances.

All lenses of this first category require a fluid to fill the water lens chamber. Over the years practically every type of chemical solution has been tried in an effort to prolong the wearing time before the cornea becomes oedematous. Previously it had been thought that the problem of corneal oedema had to do with the osmotic pressure of the contact lens solution. Clinical experience has indicated that the use of different solutions produces little or no difference in wearing time so long as the solution used is non-irritating. Solutions which irritate the eye invariably cause an early corneal oedema.

Today, the contact lens solution which is in almost universal use is a 1½ per cent solution of sodium bicarbonate in distilled water. Such solutions should be made up fresh every few days, because solutions of sodium bicarbonate increase in alkalinity on standing. So that our patients may have an ever fresh solution on hand we usually prescribe the sodium bicarbonate in capsule form, as follows:

Rx. Capsules sodium bicarbonate aa gr. vi ss
Sig: Dissolve contents of one capsule in one ounce of distilled water and use as a contact lens solution.

The addition of methyl cellulose to the sodium bicarbonate solution has proved to be a desirable practice in many cases, enough being added to make a one-third of one per cent solution. The addition of methyl cellulose makes the solution more viscid, thereby permitting it to wet the lens more readily and providing for lubrication of the lids as they ride over the lens.

As was mentioned previously, some of the lenses being fitted today are of the molded type which are made from an impression of the eye. Quite a bit of progress has been made in the impression technique in the past few years. The use of Negacol has given way to the use of the modern alginates which give more comfort to the patient and provide the practitioner with more accurate impressions. Seldom is an anesthetic required, except in the case of nervous patients who develop a blepharospasm and who generally are not good prospects for contact lenses anyway. Another improvement in the molding techique is the use of a syringe, as developed by Policoff, which permits filling of the molding shell with the alginate *after* the shell has been introduced between the lids.

At the present time some experimentation is being done with a new method for making an impression of the eye. A plastic contact lens known as a "temperature-critical fitting lens" has been developed. This lens is made of a special plastic composition so that at temperatures 3 to 6 degrees above body temperature, the scleral portion of the lens becomes soft and flexible whereas at temperatures below that of the body the lens becomes rigid. This lens is immersed in warm water (40° to 43° C.) and is then introduced into the eye. Compresses dipped in this warm water are then applied to the lids to keep the lens soft. The softened lens can be manipulated with the fingers while it is on the eye until the fluorescein pattern shows the desired clearance. Cold compresses (7° to 10° C.) are then applied to the lids to chill the plastic lens and cause it to become rigid again, after which it is removed from the eye and immediately used to produce the desired casting.

To the writer this is just another method for obtaining an impression of the eye. The method has nothing to offer that is in any way better than the molding method previously described.

The *corneal cap contact lens* is a thin meniscus of plastic with a diameter slightly less than that of the patient's cornea. Usually this diameter is 11.5 mm., although it may be slightly larger or slightly smaller in individual cases. The lens has a curvature on its posterior surface which is about 0.3 mm. flatter than the flattest meridian of the patient's cornea. The lens has a bevel for about 1 mm. at the peripheral edge of its posterior surface, which still further flattens this surface so that it will ride smoothly over the cornea without scraping the epithelium. Since the lens is flatter than the cornea, a lachrymal fluid lens is formed between the lens and the cornea and the lens is held in place by the capillary adhesion of this film of tears. However, this adhesion is not great enough to prevent the lens from sliding or lagging with movements of the eye and the lid.

When the corneal lens is fitted sufficiently loosely it rides freely upon the cornea. Examination with the corneal microscope will show that the film of tears between the lens and the cornea is constantly swirling and is quite free to replace itself.

When the corneal lens is fitted too tightly (i. e., with too short a radius), in relation to the cornea, the lens will not lag or slide, but will remain perfectly immobile on the cornea and, as may be seen by examination, the lachrymal film will be stagnant. At first a tight lens will be more comfortable than a loose lens, but after a short period of time the tight lens will become quite uncomfortable.

A properly fitted corneal contact lens will ride freely over the

cornea and in the static position it will rest so that the lower edge of the lens will ride just above the margin of the lower lid. The superior edge of the lens will be covered slightly by the upper lid. When this lid is retracted it will be noted that the upper edge of the lens is in a position just over the superior limbus. If both lids are retracted the lens will fall of its own weight to a central position on the cornea.

When a corneal lens is too flat it will lag excessively and it will tend to ride too high over the superior limbus and partly onto the sclera. Normally a corneal lens will remain on the cornea and will not slide off onto the sclera because its curve is more closely related to the curvature of the cornea than to that of the sclera. However, if the curve of the lens is too flat, the lens is liable to ride off the cornea and onto the sclera.

When a corneal cap lens is first placed on the cornea there is an immediate sensation of the presence of a foreign body. This sensation, as might be expected, varies in severity with different patients, precisely as would be the case if any foreign body entered the eye. If the gaze is directed downward, with the lids open and with both the eye and the lid immobile, the sensation of discomfort disappears almost immediately and does not return until the gaze is lifted. This would tend to indicate that the discomfort results solely from the passage of the upper lid over the margin of the lens.

In the fitting of the corneal cap lens there are two methods currently in vogue. Both methods depend upon the use of the keratometer for the selection of the first lens to be placed upon the eye. From that point on, succeeding lenses are selected on the basis of clinical observations of the lag and positioning of the lens upon the cornea.

In the method of fitting suggested by the Solex Laboratories who manufacture the corneal lens designed by Tuohy, who first introduced it in the United States, the keratometer reading of the weakest meridian in diopters is converted into millimeters with the aid of a table provided by the manufacturer. This table gives the correct radius conversion, from which value a series number is obtained with the help of another table. This series number takes into consideration the fact that the posterior lens surface must have a curve which is 0.3 mm. flatter than the cornea for a good fit.

By the use of other tables the lachrymal lens factor is determined and this value (always plus) is then added to the spherical element of the patient's spectacle prescription which is always written with a minus cylinder. The cylinder element is then ignored. After the series number and prescription have been determined, this information is sent to the

laboratory. The fitter receives three pairs of lenses from the laboratory, one pair exactly as ordered, one pair which has a radius one series number lower and another pair which has a radius one series number higher than the pair ordered.

Another system of fitting corneal contact lenses uses a trial case of these lenses. In this method of fitting, a set of trial lenses marked in either diopters or millimeters of radius is used. The lenses are marked with their true power or radii and the fitter must modify his keratometer readings by allowing either one and one-half diopters or 0.3 mm. for the flatter radius required for the corneal lens.

If the first corneal lens selected in a given case is to fit reasonably well, the keratometer readings must be accurate. Before fitting these lenses it would be well for the fitter to obtain a steel ball of known radius and to check and adjust his keratometer so that it will read accurately.

True oedema of the cornea does not occur when corneal contact lenses are worn. The writer has seen a peculiar formation of globules in the epithelial layer of the cornea following the wearing of these lenses in a few cases. This phenomenon has been described previously by Bier, and it probably accounts for the halos seen by these persons.

Cosmetically the corneal lens is excellent, it does not cause a widened palpebral aperture, a bulging of the eye or a drooping of the lower lid. The fitting technique is relatively uncomplicated and the proper lens and cornea relationship can usually be determined after a few visits. The major problem in the fitting of the corneal lens is that of comfort. Many persons have been found who are unable to relax their palpebral muscles sufficiently to allow the lids to pass over the edge of the lens without irritation. When a person is able to obtain lid adaptation so that there is no irritation, the lens seems to be ideal.

There is one question which arises concerning the handling and wearing of the lens, and that is the matter of loss of the lens. The lens is so tiny that it is easily dropped and can readily be lost. Frequently during the initial wearing time of the lens there is excessive lachrymation which sometimes allows the lens to become dislodged so that it may be lost from the eye. While we have heard reports of persons who wear these lenses when engaged in rough sports and in swimming, it does not seem logical to expect them to be suitable for such use. At the present time, insurance is being provided at nominal cost to cover the loss of the lenses. Only time will tell whether this venture will prove economically sound.

The third category of contact lenses to be considered in this paper is the so-called minimal-clearance lens. There are a number of some-

what different types of lenses which we have included in this category. All types have a scleral rim which supports the corneal section. One such lens is fitted so that the scleral rim lies rather loosely on the sclera and the corneal section is designed and adjusted so that its posterior surface lies nearly tangential to the anterior surface of the cornea. No accessory fluid is used with a lens so fitted. The limbal space fills with tears, usually within a few minutes after insertion. Usually too, there are numerous air bubbles in this region of the lens.

All lenses of the minimal clearance type provide for complete clearance of the limbal and para-limbal regions. Such lenses have been described by Bier, Mueller-Welt and others. In some lenses of the minimal-clearance type, longer haze-free wearing time is provided by ventilation of the lenses with one or more small holes in the limbal region.

Minimal clearance lenses as just described will, when properly fitted, give practically as long a haze-free wearing time as the corneal cap lens. Unquestionably they are more comfortable than corneal cap lenses. Since they have a scleral rim, the edge of the lens is far removed from the margin of the lids and if the limbal joint on the outside of the lens is smooth and transitional in nature there is no irritation of the palpebral conjunctiva as there is with the corneal cap lens.

From a cosmetic viewpoint the minimal clearance lens is usually as invisible as could be desired. However, we have seen a few cases where the bubble formation at the limbus presented an objectionable feature. Poor judgment in the location of the ventilating hole or holes in this type of lens will also cause the lens to be more noticeable.

Proper fitting of the minimal clearance lens requires painstaking and time-consuming work on the part of the clinician and usually requires many patient visits before the optimum clearance has been obtained. Unquestionably, the results are worth the effort, but until some way is found to reduce materially the time and the number of visits required to achieve the desired fit, the cost of fitting these lenses will be high.

Several years ago Feinbloom introduced a new lens which he calls a "self-centering corneal lens." While this lens, like Feinbloom's older tangent cone lens, utilizes the principal of a cone, it is otherwise quite different. The new lens has a corneal diameter of 8 mm. The radius of the posterior surface of the corneal section is 7.4 mm. Surrounding this corneal section is a cone which has an angle of 55°. Surrounding the cone section is an area, longer on the temporal edge and shorter on the nasal edge, which is available in a number of different spherical

radii. These radii are designated as Alpha, A. B, C, and D. Alpha is the shortest radius and D the longest.

In fitting this lens, the clinician selects a radius which fits the sclera in such a manner as to hold the cone in a position tangent to the cornea and in minimal clearance with it at the point of tangency. A small amount of contact lens fluid is required to fill the central 8 mm. of the cornea and to fill the space over the limbus.

The standard contour diameter of the self-centering lens is approximately 24 mm., although contour diameters of 22 mm. and 26 mm. are also available. For those cases which do not permit the achievement of adequate minimal corneal clearance by variation of the scleral radius, the lens is also available with a one-half mm. build-up between the spherical radius and the cone angle.

The self-centering lens falls within the category of minimal clearance lenses. It generally affords longer haze-free wearing time than the conventional lenses of the first category. Cosmetically it is far superior to those lenses. In most cases haze does occur sooner with these lenses than with the other types of minimal clearance lenses. The self-centering lens is relatively easy to fit and the proper lens can usually be selected from a comparatively small selection of trial lenses. This lens is quite comfortable to the average patient and can usually be worn for a number of hours on the first visit. Adjustments to the lens are quite simple and can be made by the thermal adjustment method.

SUMMARY

The conventional fluid lens is seldom used today because of its poor appearance and short wearing time. The corneal cap lens is relatively easy to fit and has a long wearing time for those who are able to develop the lid tolerance necessary for comfort. The minimal clearance lens has long wearing time and is comfortable but it is difficult and time consuming to fit. The self-centering lens is readily fitted, it is comfortable and has a longer wearing time than conventional lenses but not usually so long a wearing time as the minimal clearance type.*

*This paper was read before the International Optical Congress in London, England, July, 1951, by the author, who represented the American Academy of Optometry at this meeting.

THE DIAGNOSIS OF GLAUCOMA WITH SPECIAL REFERENCE TO ITS CHRONIC FORMS*

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Glaucoma is not a single disease entity. The dominant features of raised intraocular pressure and the effects of this pressure upon the disc have bestowed upon most glaucomas a similar life history. Etiologically, the various types of glaucoma may differ widely. However, our lack of knowledge of the basic causes underlying this disease has prevented us from developing a comprehensive classification so that we have been compelled to divide the glaucomas into two categories: *primary*, with no demonstrable previous ocular disease, and *secondary*, with a definite history of previous ocular disease. Whenever a definite, direct cause is discovered for a primary type of glaucoma, this type is at once transferred to the secondary group. This has happened, for example, with one type of glaucoma which was previously considered to be a typically acute primary form until it was established with the aid of the slit lamp that exfoliation of the lens capsule is the actual forerunner of this condition.

A brief discussion of the secondary glaucomas will be in place here. It is obvious, for example, when an intraocular tumor in the course of its growth and expansion has arrived at such a point that it can interfere with the normal fluid traffic of the eye, that the symptoms of acute congestive glaucoma will then occur. The cause of the glaucoma in this case is obviously local. It can be explained on grounds with which we are all familiar as being due to a definite interference with the drainage system of the eye. Deficient drainage may be caused either by mechanical obstruction of the filtration angle or by the more subtle mechanism of an increase in the colloidal content of the intraocular fluid resulting in an increased osmotic pressure and a higher tendency for the fluid to retain or increase its liquid volume.

Examples of this kind of secondary glaucoma are quite numerous. It will be sufficient to name only a few of the more common varieties in order to establish this class of glaucomas. Among these are: (1)

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hemorrhagic glaucoma, which not infrequently follows thrombosis of the central retinal vein; (2) glaucoma which appears in the course of a chronic or acute uveitis; and (3) glaucoma which follows operative or accidental injuries to the eye. The development of glaucoma in these cases is a mere incident, a secondary development in the progress of a more basic intraocular disease. The management of such cases requires an accurate diagnosis. This implies a definite recognition of the local cause so that the proper treatment may be instituted. This statement should be emphasized, since confusion with so-called *idiopathic glaucoma*, which will be taken up later, is not impossible. To avoid such confusion a careful history should be taken and a careful examination should be made with the loupe, the ophthalmoscope and, especially, with the corneal microscope and the slit-lamp. This procedure will usually, if not always, provide a satisfactory understanding of the case. It must be remembered that not all cases of secondary glaucoma are of the fulminating variety; for example, hemorrhagic glaucoma is of the non-fulminating type. Some secondary glaucomas are quite analogous in their almost symptomless character to the simple primary glaucomas. In such cases use of the slit-lamp may reveal a few keratitic precipitates and hence point to a secondary glaucoma with *chronic uveitis* as the basic cause.

Of the so-called primary glaucomas, an immense literature has accumulated since the days of von Helmholtz. Rapid progress was made at first with the introduction of the ophthalmoscope and with the demonstration that excavation of the disc occurs in association with a chronic increase in intraocular tension. This condition had been called, until then, "amaurosis of unknown origin." The introduction of von Graefe's method of iridectomy for the cure of acute glaucoma is a landmark in ophthalmology. Further progress came with the introduction of the use of miotics for lowering intraocular tension. In the first decade of this century, significant advances were made in the field of antiglaucoma surgery by such men as Heine, Lagrange, and Elliott, who introduced new methods and new principles for the relief of glaucoma by finding new drainage routes for blocked up intraocular fluids. At about the same period, refinements in diagnosis through the use of the tonometer and the perimeter helped to advance our knowledge of the life history of glaucoma. In the past generation, our progress in this field has not been too impressive. A number of new miotics has been added to our medical armamentarium. Though these have many virtues, they have not revolutionized the treatment of glaucoma. The introduction of gonioscopy has enabled the surgeon to visualize the anatomy of the filtration angle

and to use this knowledge as a guide in his surgery.

One of the principal goals of glaucoma research is that of finding the trigger mechanism responsible for the vascular disturbance which causes chronic or acute glaucoma. This aim has not been realized to date. To this end, however, an enormous amount of clinical investigation has been carried out by those who believe the glaucomatous eye to be the unique focus of a constitutional derangement, or as Lagrange puts it, "A sick eye in a sick body." However, clinical observations on the patient as a whole with laboratory investigations of the body fluids and studies of the endocrine glands and of the autonomic nervous system, particularly of the vasomotor system and the vascular responses, have led essentially to sterile results. One generalization may, however, be made from all these studies; namely, that glaucoma occurs more frequently in arteriosclerotics and in patients with vasomotor instabilities than in any other type of people.

Acute glaucoma is one of the easiest of diseases to recognize. A student or recent graduate sufficiently drilled in the symptomatology of acute diseases of the anterior segment of the globe should be able to identify a case of acute glaucoma almost instantly, even though he may never have seen such a case before. The three most important and unfailing signs of the presence of glaucoma will be: (1) ovular congestion; (2) a dilated, unresponsive pupil; and (3) increased ocular tension. Other supplemental signs are helpful but not essential. Among them are the following: (1) a shallow or obliterated anterior chamber; (2) corneal edema; (3) corneal anesthesia; and (4) pain in the eye and in the innervational areas of the fifth nerve. Although the pain may be excruciating at times, it is not always severe. In fact, one encounters many more cases with only mild or moderate pain than cases possessing the unbearable pain dramatized in the textbooks. There are, nevertheless, pitfalls in the recognition of this obvious malady which must be discussed, even though we as specialists whose interests are limited to the eye itself, are least likely to fall into them. Very recently, for example, I was called in to see a woman who, as it turned out, was suffering from a first, very severe attack of acute glaucoma. Her ocular condition necessitated her removal to a hospital the very same day for surgical treatment. The curious point about this patient is that her most severe symptoms were felt in the abdomen and therefore her attention was centered around that region. She experienced severe nausea and pain and suffered attacks of vomiting. A physician had been called in the day before when the glaucomatous attack first commenced. He was inclined to the belief that the patient was suffering from another attack of biliary colic. To his credit, it must be said that this general practitioner

also recognized that there was an associated eye ailment, whereupon I was called in. Not so fortunate was another patient, a man with chronic glaucoma who suffered a sudden acute increase in symptoms. During his first acute attack the patient was seen by two different general practitioners on two successive days and was given treatments for a supposedly gastrointestinal attack. The actual diagnosis was made on the third day by an ophthalmologist. This gastrointestinal phase, although physiologically interesting, should not be overemphasized, as it certainly is not a common cause of error. On the other hand, even in the milder prodromal attacks, nausea and even vomiting are not infrequently subordinate symptoms. If there are problems in acute glaucoma they are in relation to therapeutics. In this respect, it is vitally important that a correct differentiation be made between primary and secondary glaucoma. The first type very often calls for prompt operative treatment so that the sight of the patient may be saved. The second type calls for a variety of medicinal or surgical procedures, the actual treatment depending on the particular basic lesion present. For example, an inflammatory secondary glaucoma calls for deep atropinization, a course which would spell catastrophe in a case of primary glaucoma; a hemorrhagic glaucoma calls for enucleation, irradiation or retro-orbital ingestion of alcohol; while a postcataract glaucoma might well call for cyclodialysis.

The symptomatology of chronic glaucoma varies widely. A great many of the patients who present themselves to us with a chronic glaucoma are aware of no discomfort in the eye except that pertaining to vision. Their only complaint is failing vision and sometimes not even that. It is remarkable how often we find a clinic patient with a pathologically excavated disc in a nearly blind eye who apparently has given the condition very little thought and no attention. One farmer whom we saw recently in the clinic discovered his blindness only the day before, and then only because a foreign body had lodged in the cornea of the sound eye. The accident naturally forced him to close that eye on account of the pain; so that he discovered the true state of affairs. There must be many thousands of people throughout the country who are victims of a slowly blinding glaucoma and yet are not receiving treatment because of the seeming lack of urgency of the condition. As we shall have occasion to see, one of the reasons for this lack of introspection is the manner in which the disease evolves. Glaucoma almost always affects the two eyes unequally and attacks the nasal field first, so that it almost always leaves an excellent foveal acuity up to nearly the end. These asymptomatic cases, correctly called *simple glaucomas*, are the ones which most often present a real problem in diagnosis, especially when the patients offer themselves for examination at times when ophthalmoscopic

evidence of the disease is either completely lacking or doubtful in nature.

In the above connection it might be pertinent to ask, "Do these cases of *glaucoma simplex* represent the same disease as acute or chronic congestive glaucoma?" A more practical question would be, "Can a *glaucoma simplex* ever evolve into an acute glaucoma?" I do not pretend to be able to answer these questions completely, but it is my impression that true cases of glaucoma simplex differ radically from the acute types and do not as a rule produce acute attacks. It is my impression, furthermore, that glaucoma simplex patients are usually in their very late years or are elderly individuals who have an arteriosclerotic basis for their glaucomas. These patients differ in general from the prodromal type of glaucoma patient in possessing a better emotional stability. Also, in glaucoma simplex, the eye itself is apt to show a rather normally deep chamber in contrast to the narrow angle type of glaucoma seen in the acute group. It is often difficult, however, to place a glaucoma patient in the proper category. As an example, I might cite the case of a young man in his early thirties who first came to my attention because of his somewhat wide cups. His only complaints at that time were of some discomfort in reading and perhaps a slight pain. After studying his intraocular tension a great many times on different occasions, I made a definite diagnosis of chronic glaucoma. The patient was given 1 per cent pilocarpin drops to use four times a day. I watched his cups enlarging for 10 years. During this time, he was entirely symptomless throughout and his visual fields, both central and peripheral, remained quite normal. This case illustrates, I think, the transitional type of glaucoma, from the entirely asymptomatic to the very mild acute congestive. This type of case yields a series of subjective symptoms and perhaps additional objective signs which make the diagnosis of chronic glaucoma almost mandatory. The above case is not unique. There are others whose only expressed complaint is headache. One such patient was treated for sinus trouble over a period of time covering at least two years by a competent nose and throat man. If this patient had *sinusitus* he also had chronic glaucoma. However, it is a remarkable fact that he lost his headaches promptly and completely by treatment directed to his glaucoma only. I might say, in passing, that sinusitis is a convenient repository for obscure headaches, as can be seen by the perusal of a number of published case histories in proved cases of brain tumor. Glaucoma is not the only disease which can be missed by an undiscriminating concentration on the nasal sinuses. Another isolated symptom which should direct attention to a possible glaucoma is said to be the early onset of presbyopia. I will confess that I have run into very few such cases. This statement, however, does not imply disagreement. I can recall

many cases of early presbyopia in women around the age of 40, who also had an early menopause imposed on them by surgery, but who showed no signs of glaucoma. We should be suspicious of early menopause rather than of early glaucoma in these cases of early presbyopia.

The condition designated as prodomal glaucoma, then, may be so mild and possessed of so few symptoms as to escape notice. Patients who, for one reason or another, are suspected of harboring glaucoma should be questioned closely as to whether they experience rainbow-colored rings or halos, slight cloudiness of vision and slight orbital pain. Often patients are not fully aware of these attacks until their attention has been directed to them. These attacks frequently come on in the early morning, when patients may be in no position to observe details too closely. It has been necessary on numerous occasions to instruct patients to be on the lookout for these symptoms and to report to me on a return visit. The need for prompt diagnosis in the case of congestive glaucoma is more compelling than in simple glaucoma. One never knows in these cases when a severe attack may supervene with disastrous results. This is particularly likely to happen in sudden severe emotional upsets, in exhaustion from any causes, or in illness during and after operations.

My previous remarks on the symptomatology of the chronic glaucomas, whether of the simplex or of the mildly congestive variety, would give one the impression that their detection may be quite difficult. That is very true. However, in everyday practice, detection is commonly not difficult for the simple reason that too many patients are apt to seek relief after the disease has become quite far advanced so that the ophthalmoscopic examination already shows an unmistakable pathologic excavation of the disc. It is equally true that very early cases of chronic glaucoma are not uncommonly missed, at least for a time, even by the most careful and competent observers. Hence, it becomes very important to establish criteria for a definite diagnosis. Basically, these criteria are threefold. Their importance is such that I shall now take up each of these principles separately.

1. *Intraocular Pressure.* The normal intraocular pressure, according to Duke-Elder, varies between the extreme limits of 12 to 35 millimeters of mercury.[1] It may be accepted that in the great majority of people this pressure varies normally between 15 and 25 millimeters. Another fact to remember is that like other physiological functions, such as the heartbeat or the respiratory rate, the normal intraocular pressure varies slightly during the 24 hours of the day. These variations, however, do not normally exceed 2 to 3 millimeters.[2] The first point of diagnostic significance to remember, therefore, is that if the intraocular

tension exceeds the value accepted as the normal top limit, even by a few millimeters, the presence of glaucoma should be strongly suspected. If, however, a given single reading happens to fall within the normal limits, the possibility of glaucoma should not be excluded unless it can be shown that the intraocular pressure remains normal for a period of 24 hours, and that the variations in pressure do not exceed the normal fluctuations. In office practice, it is not feasible to chart diurnal variations, but this can be done in a hospital where the services of a trained resident are available. Under these conditions, the tonometric readings are taken every three hours, day and night, on three successive days. The record will show clearly whether the pressure exceeds the normal limit at any time and also, even when the pressure itself remains within the normal limits, whether the fluctuations do or do not exceed the normal values. If either the pressure or the fluctuations are abnormal, the results point to the existence of glaucoma. An alternative procedure to hospitalization, although not quite so satisfactory, is to make repeated tonometric measurements on different days and on different hours of the same day and to evaluate the findings in the same manner as above. The discovery of any abnormal tension of the eye is accepted as a certain sign of glaucoma and as an indication for treatment.

Increased tension precedes pathologic cupping of the disc and the characteristic changes in fields. The observation of increased tension is, therefore, the most certain way of detecting glaucoma in its early stages. In order to expedite recognition, resort may be made to certain provocative tests. A provocative test is one of a number of procedures applied to the patient for the purpose of observing the reaction of the eye. In most of these tests, a glaucomatous eye responds with a significant increase in its intraocular tension or even with a frank attack of glaucoma.

In one of these tests the glaucomatous eye responds by a mere dilation of the pupil. The most reliable of these tests, but one which should not be done outside of the hospital, is the instillation of homatropin in the conjunctival sac of the suspected eye. A marked rise in pressure within the first hour will establish the diagnosis and a frank attack of glaucoma, which should not be unexpected, will determine the desirability of prompt operative treatment. It is well known that the instillation of belladonna alkaloids or of even less durable mydriatics such as cocaine, ephedrine, paredrine, etc., for refractive purposes or for examination of the fundus has on rare occasions produced attacks of glaucoma. The mydriatic does not cause the glaucoma, it merely discloses it. The application of this drastic test is sometimes fully

justified. It will be recognized that the principle involved in this test is based on the narrowing of the filtration angle by an increase in the thickness of the iris at its root. Another test is the adrenalin test. In this test a drop of adrenalin hydrochloride (1:1000) is instilled into the eye every minute for 5 minutes. Glaucomatous eyes will respond with mydriasis, while in non-glaucomatous eyes the pupils will remain small. There is in this case no associated elevation of pressure. The principle involved in this test makes use of the ability of adrenalin to increase the sensitivity of the sympathetic nervous system. The action of the adrenalin is, of course, confined to the local sympathetic fibers which supply the dilator muscle of the iris. The test, however, is often vitiated by a positive reaction occurring in non-glaucomatous eyes of patients with sympathetic instability due to other causes. Furthermore, it is often negative in glaucoma itself and is, therefore, of little reliability.

It is hardly necessary to enumerate all the provocative tests for glaucoma. A considerable number of them are published in the literature. Also, new tests and modifications of old ones are being added from time to time. One of the easiest tests to perform in the office is the caffein test in which the patient is made to drink two cups of strong black coffee. Within 30 to 45 minutes, a susceptible eye will show a rise in pressure of 10 to 15 millimeters of mercury. A rise in general blood pressure always precedes the hypertension of the eye. This should not lead to the unnecessary inference that high blood pressure is related to glaucoma. Clinical observation proves that essential hypertension does not predispose a person to glaucoma, presumably because of the compensating vaso-constriction which occurs in the eye. Other tests for glaucoma which may be named briefly are the water drinking test, the decubitus test, and the dark room test. In the water drinking test, the patient is made to drink a quart of water on an empty stomach. Tonometric readings are then taken within an hour. In the decubitus test, the patient is made to lie prone on his back with his head lowered. This produces venous congestion in the head. Pressure readings are then taken. In the dark room test, the patient is kept in a dark room for an hour. This tends to produce a dilation of the pupil. The intraocular pressure is then measured. In all these tests the intraocular tension tends to rise abnormally in glaucomatous eyes. In the absence of glaucoma, the pressure remains at approximately the normal level throughout the test.

2. *Cupping of the discs.* We are all familiar from daily observation with the fact that the physiological cup or the normal funnel-shaped depression in the center of the disc varies tremendously with

different individuals as to size, shape and depth. In many eyes, the cups are said to be "closed." In such cases, there is clinically no visible cup at all. At the extreme opposite end of a series of normal cups we find the very wide, tubular and deep-appearing cups which give more than a superficial resemblance to pathological cups. These eyes are the ones which cannot be passed off lightly as being normal even though a tonometric reading or two, or even a full perimeter study, apparently prove them to be within the normal range of variations. Of course, these eyes may turn out to be normal, but I have records of such patients with an annotation to watch for glaucoma. In some patients the appearance of the disc has remained constant for 10 years with no indication of any other signs or symptoms which might lead to a diagnosis of glaucoma. Other patients, on the contrary, have turned out to possess glaucomatous eyes. Despite the admitted difficulty of recognizing a glaucomatous cup, certain appearances are extremely helpful. A decided lack of symmetry between the two cups is very suggestive. The presence of a shelving temporal margin with retinal vessels which dip and disappear only to reappear at the bottom of the cup is practically diagnostic for glaucoma. On the other hand, some retinal vessels which seem to dip may actually be found to have passed through the narrow band of nerve tissue which bounds the entrance to the cup. A wide, deep cup with shadowy vessels at the bottom, an appearance due to an increase in the glial tissue and obscuration of the lamina cribosa, spells glaucoma. If there is an associated slight pallor of the nerve tissue, the diagnosis is conclusive. Some of the pathologic cups, and they may be relatively shallow, are associated with a constantly normal intraocular pressure, a progressive optic atrophy, and field changes more or less characteristic of glaucoma. These types are occasionally seen in elderly, presumably arteriosclerotic individuals. Such cases have been the subject of controversial discussion. Some doctors have preferred to call these types pseudo-glaucoma. Duke-Elder[3] has recently restated his position, with the quite plausible assertion based on corroborating evidence, that there is in these cases a sclerosis of the nutrient vessels to the optic nerve with disappearance of capillaries, impaired nutrition, degeneration of nerve elements, formation of lacunae in the neighborhood of the lamina cribosa and cupping of the disc. These cases will show no increase in intraocular pressure, although in other respects they may behave like typical cases of glaucoma. However, Duke-Elder further states that hypertension supervenes if vascular sclerosis in the region of the anterior drainage channels follows the "posterior" sclerosis. This may never occur and hence the eye may remain with a glaucomatous cup and

may go on to complete atrophy with the tension normal at all times. Duke-Elder suggests for this type of case a possibly better name, that of "sclerotic optic atrophy." The same explanation is offered for the presence of deep cupping and optic atrophy without hypertension, as found in those cases where the sclerotic internal carotids press on the optic nerve. These are not, he says, true cases of pressure atrophy, but cases of atrophy and lacunar changes leading to cupping induced by ischemia from an associated sclerosis of the nutrient vessels in the neighborhood of the lamina cribosa.

Optic atrophy from other causes such as lues often produces wide cupping. This is another source of confusion. These cups, however, are as a rule shallow and saucer-shaped. It should be obvious that if atrophy from any of these causes occurs in an eye normally possessing a wide deep cup, a differential diagnosis can be arrived at only after a careful study of the ocular pressure and the visual fields. Occasionally, the history and a continuous observation of the affected eye are practically the only means available for arriving at a diagnosis. Some years ago I was privileged to see a patient who had typical glaucomatous cups with complete optic atrophy. It was known to the doctors who took care of him from the very beginning of his eye trouble that he was a victim of quinine amblyopia, in this case *amaurosis*. This case, however, was extremely unusual because quinine practically never gives complete amaurosis.

3. *Perimetry and campimetry.* Visual field studies in connection with glaucoma are useful to the practitioner both in making a diagnosis and in following the progress of the disease. The latter is probably the more important application. Since perimetry is a subjective test, the patient must possess adequate intelligence and powers of attention to insure accuracy. Needless to say, the examiner must also be competent. He must, first of all, know the anatomy of the retina, particularly as it relates to its nerve-fiber distribution. This he must know in order that he may be able to visualize with ease a nerve-fiber bundle defect which constitutes the characteristic lesion in chronic glaucoma (Figure 1). Second, he should also understand that nerve-fibers and nerve bundles do not just suddenly die and leave as a memorial a complete and immutable defect in the field of vision. The changes are more gradual, the evidence varying from a slight depression to a complete absolute scotoma. It thus becomes necessary, in order to find the defect, to vary the intensity of the stimulus by reducing or increasing the illumination if possible, or most conveniently by reducing to a minimum the size of the test object. Traquair[4] states that it is impossible to find the

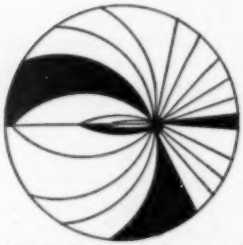

Fig. 1. Field study of the projection of the nerve fibers of the right eye. (Diagrammatic)

very early field changes which occur first in the central field in glaucoma, unless a one-millimeter test object is used at 1 meter, or preferably at 2 meters, with a tangent screen. Thus, armed with knowledge, the perimetrist will find one of the earliest signs of glaucoma to be the so-called "baring of the blind spot" at its upper pole, then a Roenne step and later a Bjerrum scotoma (Figure 2). A word of explanation is

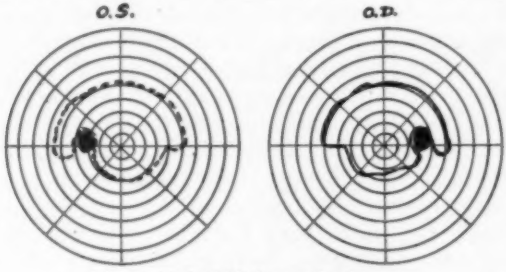

Fig. 2. Early field changes in glaucoma.

necessary here before these terms can be more fully elucidated. Visual field studies by Bjerrum and by Traquair have demonstrated that in glaucoma the first field defects lie in an arcuate area of the central field in about the 15 degree circle from the fixation point. These defects are found mostly above the horizontal meridian, although they often occur below the meridian and sometimes occur in both areas. The cause of these defects is a physiologic bloc followed by atrophy of the nerve-fiber bundle. Since anatomically there is a crowding of the fibers which enter the scleral foramen at the upper and lower temporal margins of the disc, as may be seen by a glance at the fiber map of the retina, these fibers are first to be affected by the increased intraocular pressure. Whether the fibers atrophy because of direct pressure against the sharp edge of the scleral foramen or, as is perhaps more probable, from a compression

or kinking of small nutrient vessels and capillaries, cannot be discussed here, although this point may have great relevance in relation to the exact sequence of events within the region covered by a nerve-fiber bundle. First, it must be clear, however, that a defect may start anywhere within this arcuate region and that it must, if it spreads, reach the blind spot at one end and the horizontal raphe at the other. Second, the defect broadens towards the periphery and narrows towards the blind spot: and third, the defect in the same region may attain various degrees of density and can be found as a complete defect only by a variation of the stimulus. Now, a Roenne step, it may be seen, represents no more than an unequal development of two opposed arcuate scotomas meeting at the horizontal raphe. A Bjerrum scotoma is an intermediate scotoma: that is, it lies in the intermediate region between the horizontal raphe and the blind spot. It may or it may not break through to the latter.

Though a nerve-fiber bundle defect is the typical field lesion to be found in early glaucoma, general depression of the field also occurs early and is capable of demonstration as the so-called "baring of the blind spot." When the central field is studied with very small test objects, 1 mm. in size at 2 meters distance, the field or isopter normally elicited extends roughly to the 25 degree circle from the fixation point and encloses the blind spot. In the depressed glaucoma field, the shrinkage which usually occurs in the upper field results in a merging of the upper pole of the blind spot with the depressed area above, these being joined occasionally by a narrow "corridor." This defect called "baring of the blind spot" is neither constant nor easy to demonstrate.

Later changes in the visual fields involve a continued depression of the periphery, particularly on the nasal side and on the upper or lower quadrant, or both. These changes often affect the two eyes unequally. When joined to the expanding scotoma on the same side, the Roenne step is accentuated and may then be demonstrated by more gross perimetry. The union of the arcuate and peripheral scotomata gives rise to an appearance of the loss of the nasal field first, although there is a shrinkage of the temporal field as well. These changes, however, relate more to advanced stages of glaucoma when their recognition becomes useful in noting the progress of the disease rather than in making an early diagnosis. However, field studies have their value as diagnostic aids.

In conclusion, it may be said that a study of the intraocular pressure is of the first importance in a diagnosis of glaucoma. The appearance of the cup is a close second. A study of the central fields, because of

its time consuming nature, is not on the whole quite so valuable, but is still very useful on many occasions.

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BOOK REVIEW

RESEARCHES IN BINOCULAR VISION. Kenneth N. Ogle. W. B. Saunders Company. Philadelphia, Pa. 345 pages. Illustrated. Cloth. $7.50. 1950.

Dr. Lancaster aptly states in the Foreword: "This book is an outstanding example of how an author should present his researches in a difficult subject." The matter covered in this book is based mainly upon the investigations in binocular vision conducted at the Dartmouth Eye Institute. Much of the material presented provides the scientific foundation for the clinical work in aniseikonia. Furthermore, the author has summarized and integrated the significant parts of that work into our general knowledge of the visual processes.

Part I covers the organization and sensory cooperation of the two retinas. It includes chapters on the structure of the visual pathways; the theory of corresponding retinal points; the methods of determining and analyzing the empirical longitudinal horopter; studies on the empirical longitudinal horopter; and, the empirical longitudinal horopter and monocular asymmetries.

Part II is concerned with the fusional processes in binocular single vision. The chapter titles are descriptive of the contents of the section and they are: The Phenomenon of Fusion; Panum's Fusional Areas; Fixation Disparity; The Fusion from Peripheral Retinal Stimuli; and, The Cyclofusional Eye Movements.

Part III is devoted to the problems in binocular vision when changes are made in the relative magnification of the images of the two eyes. Chapters in this section are: Optical means for Changing the Magnification of the Retinal Image; Spatial Localization and Stereoscopic Vision; The Distortion in the Stereoscopic Perception of Space; The Analytic Discussion of the Distortion in Stereoscopic Perception of Space; The Induced Effect; Asymmetric Convergence; A Theory of the Induced Effect; and, The Sensitivity of the Eyes in the Discrimination of Differences in the Relative Magnifications of Their Images.

Part IV presents the experimental and theoretical bases for aniseikonia. In this section are chapters on: The Instruments for Measuring Differences in the Magnifications of the Images of the Two Eyes; The Origin of Magnification Differences Between the Images of the Two Eyes; The Stability of Corresponding Retinal Points; and, Eye Movements and Aniseikonia.

The Theory of the Correction of Aniseikonia and the Apparent Orientation of the Cross of the Space Eikonometer are discussed in Appendix I and II. There is also a list of 259 references and a helpful index. This book brings together for the first time the salient nonclinical papers on aniseikonia and related researches in binocular vision that have been published during the last fifteen years in many scientific journals. It should be read with a great deal of interest and profit by everyone interested in the field of aniseikonia and in the general subject of binocular vision.

ROBERT E. BANNON.

COLOR CONDITIONING*

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Factories were built first to house machines. The conception that they must be places of human habitation for the workers who were to operate the machines came much later. Only today, after more than a hundred years of steady progress, after the expenditure of an immense amount of constructive effort and applied research and with the added impetus of two great wars fought to some extent on the "factory front" have we come fully to realize the implication of that essentially simple requirement that factories should be places fit for people to live in.

These first factories were built very close around steam engines with their boiler houses and their chimneys. They were products of the coal and steam age and almost without consideration they came to be grimy, gray and forbidding. Concurrently with the realization that workers are spending most of their active lives in the factory has come the development of the electric power drive and it is hardly an exaggeration to say that the combined effort of these two factors is a second revolution. The reasonable amenities of civilized home life, light, air, physical comfort, social intercourse, music, color, all have become not possibilities but accepted practicalities in our factories.

The use of color in the plant is not new. A handful of companies have been using it for years. But it is only recently that a sizeable segment of industry has come to consider its use. Now it would appear to be the time to record the ways and means, scientific and otherwise, as to how color can be harnessed for practical application and to point out some of the dangers inherent in its use.

Color affects all human lives in some degree or another. It holds a lot of magic. But understanding and intelligent direction are required. An over-enthusiastic application of color in a plant well may lead to improper uses which would defeat their own end. If color is cheerful to look at it can also be bothersome to human eyes endeavoring to concentrate on something else. There is danger that the well-meaning enthusiast will overdo things which will carry him beyond his objective

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and deprive him of benefits that might be expected from a conservative and well devised program.

It must be kept in mind that color is not an end in itself. If it is to be used in the plant it must be used with purpose. "Color conditioning" is not interior decoration for almost any harmonious display of color will please most humans: certain hues, however, are far better than others. The job in selecting colors is to work objectively and plan for results rather than mere appearance.

You do not get people to work harder and more accurately by inspiring them with color. Quite the contrary, the objective is to establish a seeing condition that provides a more comfortable and more efficient working environment.

Color in the plant should be used as a means of avoiding distractions. Men who are expected to work and to concentrate on their jobs are aided directly by wall colors that have a slightly grayish cast, by brightness ratios that are well within one to 10 and by color tones that complement materials rather than blend with them. Excessive contrasts are thereby reduced, distractions overcome. While the decorating angle is not entirely excluded, it generally results as an automatic by-product of a well done job.

There has been considerable talk about the use of color on ceilings. This may be a mistake. Colored ceilings, particularly if they look nice, may get people to glance up and away from their task. This distraction will emphasize pipes, girders and other things that certainly are not handsome and have no importance in the seeing routine of the worker.

In studies of casual eye fixation and random movement of the eyes the two factors most compelling to the attention are motion and extreme brightness. Under equal illumination all colors differ in attraction for the eye with white having far less attraction than a hue. The human eye finds an unconscious interest in hue and shows indifference to neutral gray and white.

The use of color overhead will absorb light.

If the fixtures have directional reflectors the darkness of the ceiling will be lowered just that much more.

And severe contrast, states a fundamental law of seeing, is one of the major causes of eye strain.

Obviously, color on the ceiling contributes nothing to the efficiency of the worker; whereas white, because of its high light reflecting qualities, aids the worker in his seeing task.

One of the most important factors in developing a comfortable as well as an efficient seeing environment is brightness engineering. High

visibility, ease of seeing and good seeing conditions are overwhelmingly the result of good brightness engineering.

The human eye is, to some extent, regulated by the amount of light that enters it. When the eye is confronted with dull colors the pupil enlarges, when brightness is present the pupil contracts. Since this action is muscular the eye becomes fatigued when there are too many differences in light and dark in any given area. The result is eye strain.

Studies by lighting authorities and ophthalmologists show that the eyes see best when all areas in the field of view are approximately of the same brightness. The next best situation is where the "operation" (machine or desk) is slightly brighter than its environment, by that we mean the walls and floors. The least desirable situation is that in which the environment is greatly brighter than the task.

In this connection brightness ratios within five to one are ideal (10 to one are permissible). This means that the reflected light from any given surface in any area should not be more than five times brighter than any other surface. Putting it another way, a white wall reflects about 85 per cent of light; a black machine reflects about five per cent. If we divide 85 by five we find the ratio of 17 to one. The contrast here is too great for good seeing conditions and efficiency of the worker is reduced.

DuPont "Color Conditioning" paints have been averaged in brightness to suit average building conditions, they being neither too light nor too dark, and designed to assure good visual efficiency.

A yardstick to follow when setting up proper brightness ratios is to see that the following requirements are met:

1. Ceiling should be white for maximum light reflection. 85 per cent. Since they are usually out of the direct range of vision they are not a source of glare.
2. Floors should be as light as practical with a reflecting value of 20 to 30 per cent.
3. Machinery and equipment should reflect from 25 to 40 per cent.
4. Walls should reflect between 50 and 60 per cent. If brighter than this they will introduce glare which diverts attention from the task.

Up to this point the writer has presented very little on color itself. The selection and choice of colors is important and they should be chosen not for their decorative value but for what they can contribute to the problem. Sidewall tones should be in soft pale hues having fixed reflectance values. Being slightly grayish to avoid distraction and to resist soiling. Avoid at all cost the use of brilliant colors on walls and

on machines as they tend to divert the worker's attention away from his task.

For machinery and equipment a well developed plan should be followed. Objects of minor importance, such as bins, racks and shelvings are usually kept low in color purity to relegate them to the background. Colors, particularly those which have an attraction for the eye should be used to develop concentration at the point of operation. Here the color selected should not be chosen because of personal preferences or because it appeals to the individual but the right color is that one which achieves the greatest amount of success by taking into consideration the task at hand. Color psychology plays an important part.

We all appreciate that individuals respond to color in much the same manner that they respond to sound. We have colors which are exciting and colors which are soothing, we have colors which are warm and colors which are cool, we have colors which are high in appetite appeal and colors which are low in appetite appeal, we have colors which are high in energy value and those colors which are definitely subduing; therefore the problem is to select the color best suited for the task.

Psychological responses to color should be capitalized on and color can be used to compensate for unfavorable room temperatures, either to psychologically condition the room on the cool or the warm side. Color preferences of men or women can be taken into consideration and it is often done in the arranging for color choices in men or women's facilities or in areas where one sex is predominantly employed.

In cafeterias or any place where food is served the appetite appeal of various colors can be used to good advantage. In rooms or in areas subjected to little natural sunlight, compensation for this deficiency can be secured by the use of an end wall treatment in a color such as our "color conditioning sunlight."

The ability of certain colors to make an object appear larger or smaller or to appear heavier or lighter in weight can be used many times to achieve the desired results.

In order to set up an efficient color program some experience with the subject is important. We do not feel that it is practical or necessary to try and make color engineers out of optometrists. We have simply tried to review some of the things that color can do and how it can be used to advantage in developing a more comfortable and livable working environment, as well as one that is more efficient and safer. A clean, attractive plant not only promotes good housekeeping but is an incentive to quality work. As an aid to safety, colors should be coded. One color should be reserved for a particular function and it should not be confused

with anything else. If color application is haphazard or applied to merely be decorative it serves no purpose.

The DuPont Company has developed a Safety Color Code for industry which has received wide acclaim as well as application. In this code yellow is reserved for hazards and changes in floor elevation. Orange has been selected for hazards likely to cause serious injuries such as cuts, shocks and burns. Green as an identification of first aid equipment; red for fire protection devices; blue for caution and to indicate machinery and equipment not to be moved or operated; gray, white and black have been set aside for traffic marks, waste receptacles and other less vital objects. A very definite contribution to the improved safety record being experienced by American industry has been made by the adoption and use of this safety color code.

As it is not practical to set up a standard color program which would give best results in all plants, there should be a source of information readily available to those industries and plants who wish to take advantage of this new science. The DuPont Company has trained color engineers who will analyze individual plants and make recommendations based on proven practices and past experience.

The DuPont Company is fully aware of the excellent work which your organization has undertaken and is doing, and we will welcome the opportunity of working with you on any of your visual problems in industry.

ABSTRACTS

ESOTROPIA. INCIDENCE, ETIOLOGY, AND RESULTS OF THERAPY. R. G. Scobee. American Journal of Ophthalmology. 34.6. 817-833. 1951.

In a series of 558 consecutive heterotropia cases, the author found a predominance of esotropia (82%). It was possible to give adequate treatment and get an accurate follow-up in 238 patients. All forms of therapy except formal orthoptics were given and 56.7% attained fusion.

The methods employed in obtaining the above results are given in detail. These include: history; refraction; full correction of ametropia; occlusion; pre-operative measures; surgery; compilation of data. The latter shows several interesting points, some of which are: that 19% of the cases were nonaccommodative; 66% were partly accommodative and 15% were purely accommodative; that a higher incidence (28%) of esotropia was found at birth than at any other age; that 69% of the cases occluded because of suppression amblyopia obtained visual acuity of 20/40 or better.

The author mentions that at the time his study was being conducted, no formal orthoptics were available. He states that this lack of orthoptics was a definite disadvantage to the patients but a subsequent paper will deal with a series of similar size in which orthoptics were utilized to the utmost. Comparison of results in the two studies should prove to be of considerable interest to those concerned with the treatment of heterotropia and should be of particular interest with respect to the value of orthoptics.

R. E. B.

A CASE OF AN UNCORRECTED CHILD MYOPE SHOWING PROGRESSION IN PRESENCE OF VISUAL TRAINING*

John R. Kennedy†
St. Paul, Minnesota

CASE HISTORY

R. L., age 8, was first seen on April 13, 1949, complaining of headaches and blurred distance vision. Has never worn glasses, no previous eye examinations. General health good. Had measles, chicken pox and mumps. Has never had medical attention. Religion—Christian Science. Child is good student and likes sports.

COMPLAINT

"I had headaches for two weeks but are now gone. I cannot see blackboard from back of room so I sit in the front seat."

EXTERNAL OCULAR EXAMINATION

Visual acuity, O.D. 20/60 .37M, O.S. 20/60 .37M. Dominant hand—right. Dominant eye—left.

Lids normal, conjunctiva and cornea clear. Pupil reflex full and rapid. Pupils mildly dilated. Slight head tilt to left.

OPHTHALMOSCOPY

Media clear, vessels normal as to color, ratio and distribution. Disc full and clear.

VISUAL SKILLS

Color blind—red-green. First, second, third degree fusion present far and near on D. B. series viewed in Keystone telebinocular. Perimacular suppression card passed. Vertical and lateral phorias within normal limits. Hand and eye coordination good.

ANALYTICAL FINDINGS

The one year (14 months) progress report is presented beside original analytical for comparison. It will be noted that the equilibrium findings show improvement, blur out findings in better balance, amplitude of accommodation has increased and cross-cylinder findings are relatively the same, a + .25 more is now acceptable; however, the exophoria is greater at near, subjective requires more minus and retinoscopy shows greater minus.

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†Optometrist, Fellow, American Academy of Optometry.

	4-12-49	6-1-50
Habitual Phoria Distance:	1 EXO	1 EXO
Habitual Phoria Near:	5 EXO	6 EXO
Static Retinoscopy:	—1.50 —.50 x 85	—2.00 sph.
	—1.25 —.25 x 90	—1.75 sph.
Dynamic Retinoscopy:	— .25 —.50 x 85	—0.75 sph.
	— .25 —.25 x 90	—0.50 sph.
Subjective:	—1.00 —.50 x 75 = 20/20	—1.50 sph = 20/20
	—1.00 —.25 x 85 = 20/20	—1.50 sph = 20/20
Induced Phoria Distance:	1 EXO	1 EXO
Induced Phoria Near:	8 EXO	6 EXO
Adduction Distance:	X	14
Convergence Distance:	28/7	28/12
Abduction Distance:	10/1	10/2
Vertical Phoria Far and Near:	ortho	ortho
Subjective at Near, Unfused:	R Plano 4 EXO	+ .25 8 EXO
	L Plano	+ .25
Subjective at Near, Fused:	R + .25 6 EXO	+ .50 10 EXO
	L + .25	+ .50
Positive Relative Convergence:	24	21
Positive Fusional Reserve:	28/22	24/18
Negative Relative Convergence:	18	18
Negative Fusional Reserve:	23/3	22/10
Amplitude of Accommodation:	3.50	5.00
Minus to Blur:	—1.25	—2.00
Plus to Blur:	+3.00	+3.00

DISCUSSION

On completion of the first analytical refraction the case was discussed with parents. There is no myopia present on either side of the immediate family. Younger brother, age six, has 20/15 acuity in each eye. The parents requested that corrective lenses be given only as a last resort because of their religion.

The case appeared amenable to visual training. A program was arranged for three visits per week for four weeks.

The basis for considering orthoptics is listed:

A. 20/60 V. A.
B. Low exophoria far and near.
C. Gross plus in near subjective.
D. Plus blur greater than minus blur.
E. Low amplitude of accommodation.

VISUAL TRAINING PROCEDURE

Basic skills improved on first three visits. Rotations, hand and eye coordination, cheiroscopic drawings and use of Stepping Stone series of cards showed good range of fusion. The next three weeks were devoted to polaroid projections. Base-out fusion cards. Accommodative rock training and spatial projection training on A N series. Patient was instructed in good reading and study habits.

On completion of one month training a home training program was arranged for the second month.

A three month progress report revealed slight change over original findings. A quarter more minus was indicated by retinoscopy and amplitude of accommodation was 4.00 diopters. Plus blur + 3.00. Minus blur —2.00.

CONCLUSION

Patient returned for one year progress report on June 1, 1950. Visual acuity was unaided O.D. 20/200, O.S. 20/200, unaided O.U. 20/100, and analytical refraction findings were as shown in the table.

Parents and patient reported further decrease of distance vision. It was decided that further visual training would not prevent the tendency toward increasing myopia. The subjective of latest examination was prescribed primarily for distance use. Patient will return in six months.

852 LOWRY MEDICAL BUILDING,
ST. PAUL, MINNESOTA.

ABSTRACTS

PHOTOPHOBIA: MECHANISM AND IMPLICATIONS. J. E. Lebenson. American Journal of Ophthalmology. 34.9. 1294-1300. 1951.

The distinction between the often confused terms, "dazzling" and "photophobia," is pointed out. Photophobia is usually a pathologic condition characterized by light inducing pain in the eye whereas dazzling is simply a discomforting sense of excessive brightness. In contrast to true photophobia, dazzling is not accompanied by blepharospasm and lacrimation.

The author reviews the work of others relative to the mechanism of photophobia. The blinking rate had been used by other investigators as a valid criterion of the degree of photophobia. Lebenson re-investigated the subject by determining the threshold stimulus of light required to produce photophobia. He used spectacles with rotating polaroid filters to which protractors have been added and he measured the degree of photophobia by the percentage of light transmitted through the polaroids at the first excitation of pain.

Treatment of the affected eye with drugs (epinephrine, neosynephrine, homatropine, etc.) indicated that epinephrine consistently reduced photophobia in cases due to conjunctival, corneal, and iridic disease, or due to head injury or migraine. In view of the clinical relief afforded by the instillation of epinephrine, the significance of vasodilation in the causation of photophobia is indicated.

One implication the author derived from his investigation is: "If the entity of conjunctival asthenopia was more widely recognized, fewer patients would be wearing negligible corrections, tinted glasses, or lateral prisms." Besides the external and internal medication that may be used to control photophobia, the author mentions the use of the variable density polaroid since, in sensitive eyes, light transmission of two to six per cent may be sufficient to cause photophobia. The author concludes that the blinking rate is not a valid measure or criterion and any deductions based thereon are of questionable, if any, significance.

R. E. B.

THE BRITISH OPTOMETRIST TODAY*

D. C. Still†
Ensbury Park, Bournemouth, Hants, England

July, 1948, marked the inception of the National Health Service in Great Britain, and American readers will have heard of the unprecedented demand for spectacles, false teeth, and free medical advice that swamped the professions concerned.

During the first week or two the British optometrist was not very busy. Spectacles free? It seemed too good to be true and there was a short, relatively slack period whilst the public adjusted itself to the idea. Then the great rush started. Klondyke pales into insignificance by comparison. Most optometrists were carrying out at least 30 refractions a week; some 50, some (whose high-speed efforts are deplored by the majority, by the way) managed a hundred weekly!

The rate of payment at that time was 15/6 for sight testing, plus 25/- dispensing fee per pair of glasses required. At the rate optometrists were working at that time this represented a good living, but few had any illusions about the future. It was too good to last, so hay was made while the sun shone with the sure knowledge that there would be no second crop. Threats of cuts were impending and in any case the Ophthalmic Service was only, in official language, "temporary."

The British optometrist was only too well aware that at some future date ophthalmic optics as he knew it would be finished, and all he could hope for was to find himself among the two-thirds of Britains' optometrists for whom there would be a job in a clinic. A somber thought that, and it remains at the back of his mind to this day.

In due course cuts in the fees payable were announced. The individual optometrist realized with a shock that State optometry was as autocratic as it was bureaucratic; his complaints passed unheeded beneath the anxious treasury demands that the cost of the scheme be reduced. Then the small payments the public were required to make—such as 1/6 for a pad bridge type frame—were increased, but not sufficiently to stem the heavy public demand. The manufacturers were the next to suffer. Wholesale prices were cut 10 per cent without delay at the behest of the authorities, and the individual optometrist found his

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stocks of Health Service frames and lenses devalued to this extent overnight.

New regulations and amendments thereto reached the dazed optometrist in an increasing flow. His receptionist did not always prove equal to the task of coping with the changing prices and the queries that arose. Could this patient have a retest under the N. H. S.? Was that patient likely to receive a grant for the repair of his spectacles? More and more the optometrist had to be called in to explain just how the rules applied to an individual case. He often did not know himself, and, as might have been expected, the anomalies increased with the passage of time.

Then in January, 1951, a vague official document reached him threatening dire punishment should official records suggest him to be guilty of "over-prescribing"—that is, to quote the Amendment itself: "Where it appears to the Committee . . . that there is a prima facia case for considering that, by reason of the number of glasses and the type of lenses prescribed in relation to the number of sight tests undertaken and to the degree of refractive error present, the cost incurred by the Council has been materially in excess of what was reasonably necessary for the proper treatment of the persons concerned, the matter shall be further considered by the Committee as hereafter provided."

Thereafter several paragraphs hinting at the things the Committee might decide to do in such a case, followed by the inevitable "Explanatory Note." (The power of the Executive Councils is not generally appreciated by our trans-Atlantic friends: a practitioner against whom some kind of double dealing under the N. H. S. can be shown is not prosecuted and fined—a sum of money is simply "withheld" from his remunerations by the Executive Council for his area!)

Exactly what this meant as is usually the case with Health Service Amendments, was not clear, and it remains obscure to this day. Is the optometrist likely to find himself on the carpet for altering prescriptions by 0.25 D. because the Committee happens to think 0.50 D. the least by which an ophthalmic prescription should be changed? The basis remains a mystery, though the writer must in fairness admit that he has not so far had any of his alterations to Health Service prescriptions queried. Over-prescribing can be an abuse, but it is uncomfortable to have to consider the opinions of a Committee in addition to the refractive error of one's patient.

And then on May 21, 1951, came the unkindest cut of all. In addition to whatever small payments the patient had to make towards his frame or curved lenses, a charge of £1 was made for each pair of

glasses prescribed. The effect was electrical. Unaccustomed, after nearly three years of practically free spectacles, to paying more than a few shillings, the British ametrope staggered under this latest blow and shows little indication yet of having recovered. A little more "private" work (rimless and other fancy frames not covered by the Health Service) came into being, but the total amount of work dropped to about a third of its previous volume. In theory the hard-up patient could apply to the Public Assistance Board for a grant towards the cost of necessary glasses; in practice, of course, the majority of the deserving cases go without rather than suffer the ignominy of accepting what they describe as "charity."

Patiently through the summer months the optometrist sat, quietly recuperating from his prodigious efforts of bygone days and hopefully anticipating a marked improvement in the Autumn. But the improvement has not materialized as expected. Hardest-hit is the employee optometrist, who is now more dependent on keeping his job than at any time in the past. "Vacant" columns in the professional journals list some weeks only two or three situations in the whole country that a qualified optometrist could fill. And the "Practices for Sale" column looms correspondingly larger. So far as the manufacturing side of optics is concerned, things are even worse. Several small mushroom organizations have already closed down, and more, it is said, will follow. Representatives of the various wholesale houses are worried though, they tell themselves and their clients hopefully, things cannot possibly get any worse. Perhaps they are right. The only worse development the writer can imagine is the establishment of the long-threatened ophthalmic clinics, but with the present restrictions on Health Service expenditure these seem unlikely to materialize for a considerable time. Moreover, the volume of work is probably at about the lowest level it can reach under the present circumstances; we are probably in the middle of a latent period during which the accommodative amplitude of our prospective presbyopic patients drops that last critical 0.25 D., compelling them to obtain new lenses even though this now means resorting to payment.

It is not suggested that the Health Service cannot be a great step forward towards the improvement of the nation's health. Prior to its inception too many poverty-stricken unfortunates struggled to read with borrowed spectacles; too many people suffered the ravages of disease because they could not afford medical attention. The problem is to limit public demand to reasonable proportions without harassing the professions with a mass of avoidable legislation, and to ensure that the indi-

vidual practitioner receives a financial reward commensurate with his best efforts.

Well, the demand has certainly been limited. But whether the method of limitation by pricing is fair, whether the optometrist is getting a square deal, and whether there is much hope for the future of optometry in Britain, the reader is left to judge.

16 DRAYCOTT ROAD,
ENSBURY PARK, BOURNEMOUTH,
HANTS, ENGLAND.

ABSTRACTS

WHAT CAN THE OPTOMETRIST CONTRIBUTE TO THE EARLY RECOGNITION OF GLAUCOMA? Peter C. Kronfeld. M.D. Journal of the American Optometric Association. XXI (9). 484-488. April, 1950. Also, The Optometric Weekly. 533-536. April 13, 1950.

Dr. Kronfeld states he does not imply that optometrists are not doing their share in the early recognition of glaucoma. He recognizes that optometrists make a greater contribution to early detection than do ophthalmologists (in the U. S.) as optometrists are in contact with a larger section of the population than the smaller group of ophthalmologists.

Difficulties in early recognition of glaucoma are due to its fluctuating nature and the diagnostic methods in use. Most glaucomas here are the chronic, insidious type, causing usually only one subjective symptom, the gradual loss of visual field following a definite pattern. Detection is primarily up to the doctor as most patients with chronic type glaucoma are unaware of field changes because of retention of 20/20 visual acuity and normal reading ability despite a nasal step in one or both eyes.

The author advises inclusion of detection tests in all routine eye examinations to insure detection of early stages of chronic glaucoma. He recommends recording the shape, position and depth of the excavation of the optic discs. The differences between a normal and a glaucomatous appearance of the optic discs are outlined.

Relative to digital tonometry, Dr. Kronfeld's experience is that the sense of touch is a reliable indicator of *softness* of the eye.

In acute glaucoma, marked subjective visual changes are noticeable by patients: the classical phenomena of colored rings around lights, dim vision, congestion and pain. Dr. Kronfeld believes words like "rainbow," or "halo" are not meaningful to patients. He prefers to ask, "Do you have spells during which your vision isn't quite as clear as usual?" Patients with early senile cataracts and temporary visual disturbances also often report rainbows, the author points out.

R. E. B.

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A DILEMMA IN DISPENSING

There is one angle of the whole problem of dispensing ophthalmic materials that has not been given the consideration it requires. This problem revolves around the precise method of handling the somewhat awkward situation which arises when an ophthalmologist's patient inadvertently calls at an optometrist's office and asks him to fill a prescription he had just received from the ophthalmologist.

The optometrist is aware that the rules of practice of the American Optometric Association prohibit him from filling the prescription as requested, and his own professional training as a refractionist makes him somewhat unwilling to play the part of an ophthalmic dispenser for others as he would if he fulfilled the request. In addition, being a gentleman, he cannot stiffen haughtily and order the patient from the premises. Just what should be done?

In review let us say that optometrists believe that the public is best served when the same individual who has examined and refracted the case supervises the dispensing of the materials prescribed. This belief is not generally shared by ophthalmologists, who, in general, are not interested in the technical phase of opticianry at the dispensing level as they usually prefer to delegate that portion of eye care service to a qualified optician.

Until the federal government acted on this matter, most ophthalmologists' patients were directed to a particular dispenser, and the problem was not much in evidence. Since the now concluded federal suits, many ophthalmologists write a prescription and merely turn the patient loose to seek his glasses, and the problem has become more acute.

Before attempting to solve the question of just what the optometrist should do in the case mentioned, we first should point out that it is none of our business, as optometrists, how ophthalmologists handle their patients. We must, however, if we are to work harmoniously with them as consultants, consider the occasional contact we may have with their patients, and thus with them, in this matter.

In the situation mentioned a good deal of tact is required if hard feelings are to be avoided. A curt statement that you will not fill *his* prescription is bound to be repeated, and will eventually get back to the writer of the prescription who is apt to greet this statement with mixed emotions. It is also true that you cannot deny dispensing materials as it is quite possible that the patient knows of someone who has gotten his glasses from you.

In the situation mentioned, it is necessary that you maintain your own professional self-respect. It is also necessary that you retain the respect of the patient who, obviously, would not have sought your help had he not regarded your ability to serve him with some favor. In addition, it is necessary that you do nothing to raise any question as to the skill of the writer of the prescription. To do the latter would do you far more harm than anyone else.

What then, can be done? In the first place, I recommend that you sit down with the patient and talk the matter over. You might start by asking if he has been sent to you by the ophthalmologist who has made the refraction. If not, you might then inquire as to what instructions the patient received when the prescription was given to him. If the instructions were vague or indefinite, you are then free to explain to the patient that your practice is limited to your own optometric work and that, while you know or have heard of the ophthalmologist who wrote the prescription, and he is a good doctor, you regret you cannot

fill the prescription as the optometric code of practice forbids your doing so. You might suggest at this point that if the patient cares to have you do so, you will be glad to suggest the names of dispensers who specialize in filling prescriptions. Your handling of the problem in this tactful manner will enhance your standing as a professional man, will save face for the patient, and eliminate one of the possibilities for friction between yourself and the ophthalmologists in your community.

CAREL C. KOCH

HOLIDAY GREETINGS

A very Merry Christmas and Happy New Year to all from the Journal staff! And a very warm "thanks" to our subscribers and advertisers for their continued loyalty and support during the past year.

TRANSACTIONS OF THE AMERICAN ACADEMY OF OPTOMETRY

A department devoted to announcements, reports, appointments, organization data, news, professional problems and ideals, as these relate to the Academy.

LOCAL CHAPTER ACTIVITIES

ILLINOIS CHAPTER

The Illinois Chapter of the Academy held a dinner meeting in Chicago on October 27, 1951, followed by a program planned by Dr. Eugene Freeman, Dean, Chicago College of Optometry. Dr. John Christakos, David Michaels and Z. J. Bruce Schoen spoke on the "Problem of Visual Direction."

JOINT MEETING—TENNESSEE AND ARKANSAS CHAPTERS

A joint educational program was sponsored October 25 by the Tennessee and Arkansas chapters. Six educators spoke at the one-day meeting in Memphis, Tennessee. In the morning, Dr. J. Stanley Rafalko, Southern College of Optometry, talked on "The Ciliary Muscle Antagonism;" Dr. Charles Brown, North Little Rock, Arkansas, on "Stereo Disparator Training," and Dr. Chester A. Pheiffer, Southern College of Optometry, on "General Procedure for Training the Strabismic." Appearing on the afternoon program were Dr. Irving P. Filderman, Memphis State College, "Visual Case Study—Ten Year Old Non-Reader;" Verna L. Vickery, M.S., Community Reading Clinic, Memphis, "Educational Case Study—Ten Year Old Non-Reader;" Dr. M. E. Broom, Southern College of Optometry, "Illumination Factors Related

to Classroom Vision." A forum also was held in the afternoon, with Dr. Filderman as moderator, on "Vision and Its Relationship to the Academic Achievement of the Child."

MARYLAND CHAPTER

Dr. Israel Dvorine was the acting chairman of the October dinner meeting of the Maryland Chapter. Plans to attend the annual meeting of the Academy were discussed by the members present.

CURRENT COMMENTS

Virginia Huck
Editorial Assistant

Optometrists will confer a favor by sending news items of general interest for this department: such as relate to new instruments, clinical techniques, education, visual health and optometric legislation and organization.

CAMPUS NEWS

Dr. Harold Fisher, New York City, was the guest speaker at the first of a series of educational lectures being sponsored by Alpha Chapter of Omega Epsilon Phi, Columbia University. Dr. Fisher talked on the practical aspects of aniseikonia.

News from Los Angeles College of Optometry: recent faculty changes include three new clinic assistants, Drs. Alan Liker, Morton Levy and William Fegelman. . . . Dr. George Elmstrom has been appointed director of public relations. . . . Dr. Monroe Hirsch, director of postgraduate education, has been promoted to professor of Optometry. . . . Three major research projects are currently under way, on television viewing, the electro-encephalographic method of measuring visual fields, and myopia.

Northern Illinois College of Optometry is offering two tuitional fellowships of $500.00 a year each, announces Dean Richard Feinberg. They will be available for the February and September, 1952, semesters. January 15, 1952, is the deadline for applications for February registration.

In Germany, Dr. Hermann Pistor, dean and director of the Jena College of Optics, passed away October 1, at age 76. Dr. William Schumann of Vineland, New Jersey, who studied under Dr. Pistor, tells us that the German educator was more than just a teacher—he was a father and friend to each of his students. He was the recipient during his lifetime of many awards for his contributions to the field of visual science, among which is the order of the Royal Society of Physics of the United Kingdom.

Alpha Chapter of Phi Theta Epsilon, Pennsylvania State College of Optometry, celebrated its 30th anniversary this Fall, with a dinner dance and the establishment of a memorial trophy in honor of outstanding visual scientists. The trophy will be inscribed annually with the name of the person voted by the fraternity to have contributed the most during the year to visual science. At the banquet, Dr. Harold Simmerman, a member of Phi Theta Epsilon, P.S.C.O. faculty member, and President, American Academy of Optometry, was honored for 1950. The trophy will remain in possession of the fraternity, and the recipient of the award will receive a certificate of merit. Guests of honor in addition to Dr. Simmerman, were Dr. William Feinbloom, New York City, contact lens specialist, and Lieutenant Donald C. Carroll, optometrist, stationed at Walter Reed Hospital, Washington, D. C. Each guest spoke briefly.

NEWS BRIEFS

Grants totalling $8,942.00 have been announced by the National Society for the Prevention of Blindness for medical research on eye diseases and defects that can lead to blindness: $3,000.00 to the Massachusetts Eye and Ear Infirmary, Boston, to help study the possibility of using metal or plastic substitutes for living corneas in the corneal transplant operation, and to aid in a study on treatment for detached retina. $1,600.00 to Western Reserve University, Cleveland, for research on the use of Cortisone in combating inflammatory eye diseases, the effect of methyl alcohol on eye tissues, and eye nutrition. Also $1,500.00 for study on why cataracts develop in the eyes of some diabetics. To Washington University School of Medicine, St. Louis, $1,842.00, for research on glaucoma. $1,000.00 to the McMillan Eye Clinic, St. Louis, for a survey on the treatment of crossed eyes. Part of the funds in the Western Reserve and Washington University grants came from New Eyes for the Needy, a New Jersey organization. Announcement of the grants was made by Dr. Franklin M. Foote, executive director of the Society. . . . Glenn Wooters, formerly a member of Bausch & Lomb's scientific bureau, has joined the research staff of Titmus Optical Company, Inc. . . . "Eyes Right," a full color movie produced by Univis Lens Company, has now been seen by more than 400,000 people. . . . The Red Cross has awarded a citation to Titmus Optical Company, Petersburg, Virginia, for its outstanding participation in its blood donor program.

ACADEMY CONVENTION REPORT IN JANUARY

A full report of the annual meeting of the American Academy of Optometry, December 8-11, will appear in the January, 1952, issue of this Journal.

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This is an index covering all of the departments of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY. The letters used to explain in which department the material indexed appears are as follows: (OP), Original Paper; (E), Editorial; (T), Transactions of the Academy; (CC), Current Comments by Virginia Huck; (SR), Special Reports; (C), Correspondence; (Ab), Abstracts; (BN), Book Notices; and (A), Announcements.

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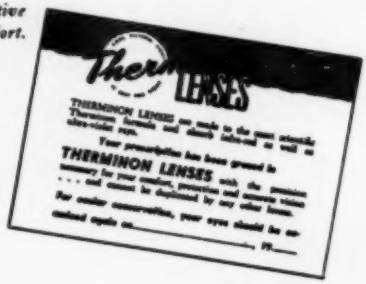

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